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RESEARCH PAPER

Operational Effectiveness of Centralized Nursery for Small-Scale Forestry in San Carlos City, Negros Occidental, the Philippines: Lessons Learned in Seedling Production for Commercial Energy Crop Plantations

Agus S. Kadda · Andy M. Venus · Danilo B. Lataza · Maria Rosa E. Solis

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Abstract One way to maximize potential income of smallholder tree farmers is to ensure high quality of planting material. In San Carlos City, Negros Occidental, the Philippines, great importance is placed on seedling quality because Energy Crop Plantations (ECPs) managed under a Short-Rotation Coppice (SRC) system will involve a single planting for several three-year coppices. High seedling quality requires superior seed provenances and seedling propagation methods. Throughout the establishment of the nursery facility, and the propagation of planting stock, data collection, reporting and database systems have been designed to capture relevant costs and technical information. Training has been provided to nursery personnel and labourers to enable them to operate the nursery and produce high quality seedlings. This paper reports a practical operational evaluation of all materials and procedures followed in nursery establishment and seedling production. Economies of scale in nursery operation are achieved at a production level of at least 90,000 seedlings per planting season of three months in the year. The production cost is estimated at PhP 3.57/seedling, excluding the cost of the nursery infrastructure and overheads. Cost comparison with decentralized or contracted nurseries shows little variation at a total cost of PhP 4.12/seedling. However, with these alternative nursery arrangements there is high risk of producing low quality seedlings by possible reduction of inputs and skipping quality enhancement procedures to reduce production cost.

Keywords High quality seedling · Short-rotation coppice · Sturdiness index · Production cost · Quality enhancement procedures

A. S. Kadda · A. M. Venus · D. B. Lataza · M. R. E. Solis
GENESYS Foundation, Inc., Emerald Arcade Bldg., City Centre, San Carlos City, Negros Occidental 6127, Philippines

A. S. Kadda (✉)
Bronzeoak Clean Energy, Inc., Suite 1207 Security Bank Centre, 6776 Ayala Avenue, Makati City 1226, Metro Manila, Philippines
e-mail: askadda@yahoo.com

Introduction

The Philippines as an agricultural economy produces an abundant biomass resource, which can contribute substantially to the country's energy supply. For the period 1994–2002, biomass accounted for 26% of the total energy consumption of the country, being extensively used as fuel, particularly by the residential, industrial, commercial and power generation sectors. The most commonly used forms of bioenergy in the country are woodfuel, wood wastes and other agricultural residues including sugarcane bagasse, coconut husk and shell, rice hull and straw, and industrial and animal wastes. Fuelwood mostly dominates the total bioenergy consumption, but the share of agricultural residues has been increasing from an average of 26% during 1994–1995 to 35% in 2001–2002. Due to the individual substantial contribution of sugarcane bagasse to industry use, amounting to 14% during 1994–2002, it is itemized separately from other crop residues. Bagasse—which is generated during the milling of sugarcane—is mostly used as fuel in sugar mills to produce steam for power generation and for sugar processing (Abdula 2006).

Although the coppicing characteristics of some tree species have been widely observed and utilized by farmers in developing countries, especially in South-east Asia, few farmers have grown coppicing tree species using the system of short-rotation coppice (SRC) on a commercial scale due to market unavailability. Farmers plant coppicing tree species mostly for fuelwood for cooking purposes.

SRC has a long history in Europe (especially Sweden), with poplar and willow being two major species. Short-rotation woody plantations for energy use have been established in the Philippines as far back as the 1970s. Energy crops consist of high-yielding tree species, harvested commonly every three years (Perlack et al. 1995).

During 1979, over 60,000 ha in energy crops were planted in the Philippines, and supported about 60–70 wood-fired electric power plants (Durst 1987). Energy crops can be used as fuel in power generation and heating systems, to substitute for fossil fuel and hence reduce greenhouse gas emissions. An energy crop plantation could be viable up to 30 years before re-planting becomes necessary.

According to Durst (1987), wood to supply power plants in the 1970 s was grown by upland farmers and managed by government agencies, mainly the National Electrification Administration. The harvest cycle of the tree plantations spans every 3–5 years and the production technology for these tree plantations is characterized by relatively intensive use of labour and forest land and by supplementary use of variable inputs, equipment, tools and transport. At present, a substantial area of denuded and degraded forest land is being considered for reforestation and bioenergy plantation projects.

Project Rationale

San Carlos Bioenergy, Inc. (SCBI) will be pioneering the production of sugarcane-based bioethanol in the Philippines. Bronzeoak Ltd. together with Bronzeoak Philippines and other investors are establishing the first Philippine bioethanol plant

in San Carlos City, Negros Occidental. Aside from producing ethanol, the plant will produce eight mega-watts (8 MW) of energy through cogeneration, with about 2–4 MW available for export to the local electric cooperative. The cogen plant will be fueled entirely by locally available biomass resources, mainly bagasse (80%) and with woody biomass (20%) as supplemental fuel. About 34,000 tons of wood is required annually to blend with about 136,000 tons of bagasse to cogenerate the 8 MW. Both the bioethanol plant and cogen facility are scheduled to commence operation by November 2008. In order to meet the woody biomass requirement, about 850 ha every year for 3 years or a total of 2,550 ha of idle and marginal upland will be converted into energy crop plantations (ECP) using a short-rotation coppice system. A sufficient quantity of high quality seedlings is needed to meet the planting schedule. A 2 $\times$ 2 m spacing would require 2,500 seedlings/ha, excluding allowance for 20%, mortalities at nursery and in the field, bringing the total seedlings to be produced to 3,000/ha.

GENESYS Foundation Inc (a non-profit environmental NGO based in San Carlos City, Negros Occidental, the Philippines) has been appointed to consolidate potential farmers who are interested to establish energy crop plantations and link the farmers to the cogeneration plant. GENESYS also provides technical assistance to farmers from seedling production to plantation establishment and harvesting. GENESYS works on watershed rehabilitation and reforestation projects, solid waste management, and coastal resource management. GENESYS was able to secure a grant to construct a nursery to produce seedlings for farmer participants in woody biomass production during the period of 2006–2007.

Considering the low income conditions of upland farmers of San Carlos City, it is set as a requirement by GENESYS that a participating individual grower of energy crop plantations should have a total area of at least 3 ha for energy crop plantation. This is to ensure economies of scale, while maintaining a portion of their area for cash crops to meet interim needs. There is some flexibility to accept a smaller area to give equal opportunities to interested poor farmers with smaller holdings. Planting is programmed in such a way that one third of the total area is planted every year and planting is completed over three years, spreading the capital outlay which farmers must make. With the 3-year rotation, harvesting can be done every year starting on the 4th year which then provides a continuous annual income for farmers from sale of wood (Segaran et al. 2005; Segaran et al. 2006).

The Local Government Unit (LGU) of San Carlos City committed financial assistance in 2007, limited for seedling production and plantation establishment cost, as loans without interest to low-income farmers. This LGU fund would be sufficient to cover a total area of 300 ha or 100 ha every year for 3 years, to continue the project beyond 2007. The progress of the project during 2006 and 2007 was slow, with a total area planted of less than 100 ha, because most upland poor farmers do not have sufficient capital for seedling production and plantation establishment. Most of the farmer participants were either corporate farmers or average- to high-income farmers who could afford seedling and establishment costs.

This paper examines the operational effectiveness of a centralized nursery for smallholders establishing Energy Crop Plantations (ECP). The paper is drawn from experiences and lessons learned in seedling production for commercial ECP in San

Carlos City. The paper first describes characteristics of centralized nursery, and tools and equipment. This is followed by a discussion on characteristics of short rotation coppice, operational plan for annual seedling production and seedling production regime. Finally, results and discussion on operational effectiveness of a centralized nursery are presented.

Description of the Centralized Nursery

The term *centralized nursery* is used here to denote the operation and management of a nursery that supplies seedlings to a wide catchment of smallholders, to target areas for planting within a 50 km radius. In order to minimize capital expenses on trucks, seedling transport to the nearest roadside of each farm is contracted to commercial trucking firms. The hauling cost is PhP 0.55/seedling, for a maximum 50 km road distance from the nursery and appropriate hauling truck capacity.[1] A centralized nursery was established by GENESYS Foundation in 2006 to produce and supply high quality seedlings to farmers. The capital for establishment of the nursery came from a grant from San Julio Realty Inc., a local construction and real estate firm. This nursery with all supporting facilities and tools and equipment is managed and operated by GENESYS. In the absence of grant funding, farmer participants can also combine their efforts in shouldering the capital requirement to set up nurseries in their respective sites.[2]

The GENESYS funding was sufficient to construct a nursery and supporting facilities capable of producing seedlings sufficient for planting 90 ha annually. This nursery has been used for two years to produce seedlings for farmers with individual areas ranging mainly from 3 to 12 ha. Seedling direct costs are charged to farmers but not overhead costs or amortization of the nursery structure. The nursery structure is made of bamboo and three layers of ordinary black shadenet as roof and one layer of side wall to minimize capital costs (Figs. 1 and 2). The structure is semi-permanent in nature with cement post bases and posts made of mature bamboo which provides extra strength and durability. This type of nursery would normally last for at least three years before major repair is required. Nursery staff and labourers were provided with necessary training so that they would be able to produce sufficient seedlings that meet the quality standards set by GENESYS as consolidator and supporting agency.

Polyethylene bags are used as seedling containers, instead of seedling tubes, also for cost reasons. When using polybags, negative impacts on seedling quality such as root deformation (root coiling, entanglement, pot bounding, strangulation) and

[1] Using small trucks will make transport cost per seedling unit high thus will exceed the budget, while too large trucks may not able to traverse local roads or difficult terrain to planting sites. In some case, buffalo-pulled carts are used to further transport and seedlings to planting areas and for infield transportation.

[2] GENESYS has also been consolidating individual small-scale farmers to establish ECP and linking them with the market, i.e. the cogeneration plant. It provides seeds and technical assistance on nursery establishment and operation. It also prescribes the seedling production regime, and assists with plantation establishment, care and maintenance, and monitoring.

Fig. 1 Manually retractable 3-layer roof

absence of air-root pruning cannot be prevented, but can be minimized by deploying specific quality enhancement procedures.

The overall nursery system consists of a simplified germination house, shade house, work shed, seed processing centre, seed testing station and seed storage area, and office. The work shed is intended as an area for media preparation. Water supply comes from an existing deep well. The water is pumped to an elevated 6,000 l storage tank. Water from the tank is gravitated through pipes to individual faucets to which hoses are attached. Seedlings are manually irrigated using hoses.

The office inside the nursery compound houses administrative functions of the nursery including records pertaining to nursery operation, e.g. of seed collection, seed storage, germination and seedling dispatch. Seed is stored at a nearby area and close to the seed testing station or laboratory to facilitate movement of material and personnel. The seed testing station has facilities and tools for basic seed tests including germination testing, determining moisture content, seed purity testing, and several indirect viability tests including cutting test, squash test, tetrazolium chloride (TZ) test,[3] and flotation test.

Nursery operation starts by the second week of February every year to enable production of seedlings ready for planting by mid-May to July the same year. The planting schedule and seedling production must be under close coordination in terms of logistics of supply chain management.[4] For this purpose, seedling orders

[3] This is a rapid method of testing seed viability (1–2 days), applied when quick decision about seed purchase needs to be made. Seeds are soaked in the TZ solution, and if viable the radicle becomes bright red in colour.

[4] An Excel spreadsheet is used for modeling the seedling production scheduling.

Fig. 2 Use of plastic sheets at the base of polybags

detailing quantity of each species and areas to be planted and their locations, should be made by the planning department of the project and submitted to the nursery department some time between January and October of the year before the planting year, to allow nursery personnel to procure the required seeds. The seedling order will trigger seed collection and eventually seedling production by nursery personnel.

Characteristics of Short-Rotation Coppicing System

SRC is a specialized form of forestry plantation consisting of woody plants which are harvested at intervals of a few years, commonly three years, by cutting the main stem (and any secondary stems) close to the ground. The *stool* or stump develops multiple shoots each time the coppice is cut (British BioGen/DTI 1999). This is illustrated in Fig. 3.

Since most of the propagules are established from seed, issues relating to seed availability, seed quality, and seed storage and germination requirements were resolved at the project planning stage. Apart from the nursery structure and facilities, tools, equipment and seedling containers used, one of the keys of successful woody ECP under the SRC system is the use of high quality planting stock. The fact that these plantations are expected to use the natural coppicing ability of the species for stand renewal places high importance on the quality of seedling material. Success will depend also on having an adequate supply, not just of the desired species, but of the specific variety or provenance of species that is best suited for each plantation site (Tolentino 1989). Many first-time plantings fail

Fig. 3 *Melia dubia* showing coppicing capability

because of lack of access to high quality planting materials. A common problem is insufficient supply of selected material so the tendency is to use low quality material to meet planting goals. Obtaining rapid growth early is critical for short-rotation systems, and time and money should not be wasted on planting low quality material (Perlack et al. 1995).

Poor planting material might not be able to provide the expected yield after one or two rotations and therefore stand renewal will entail much higher cost, with stump removal and site re-establishment. Therefore, an upgrade from the traditional methods in seedling production is needed to improve the quality of planting material. In collection of seeds, high quality mother trees have been identified. The fruiting season and seed maturation period is recorded in a GIS database for future collection (Kadda et al. 2005). A seed production area was established for future commercial seed production.

Energy crop plantations managed using the SRC system have the following characteristics and requirements:

- Fast growing and coppicing tree species.
- Preferably, high tree species diversity, with a special focus on indigenous species.
- Trees with wood of relatively high specific gravity and density (at least 0.3 g/cm^3).
- High-density planting and harvested on a short-rotation basis (3 years).
- Species-site matching.
- High genetic quality stock (reliability and abundance).

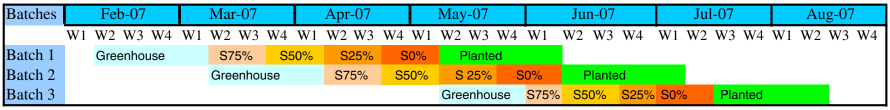

Fig. 4 Schedule of batches of seedling propagation 2007. *Note*: 'W' refers to the week number within the month. Percentages after the 'S' represent degree of shading. S0% indicates full sunlight)

- Intensive plantation management including weed control, soil amelioration (such as mulching and application of compost-based fertilizer and—in the extreme case where topsoil is very thin and organic matter is very low—re-introduction of beneficial microorganisms) and pest and disease control.

Based on the result of trials on site-species matching and growth and yield conducted at six sites in San Carlos City, the following tree species meet the requirements for ECP: *Acacia auriculiformis, Azadirachta indica, Calliandra calothyrsus, Gliricidia sepium, Gmelina arborea, Leucaena collinsii, Leucaena leucocephala* var. *K636*, *Melia dubia, Parkia roxburghii*, and *Senna spectabilis* (Tolentino et al. 2005).

Operational Plan and Seedling Production Regime

Seedling production is divided into three batches annually to optimize output from the limited nursery capacity and to reduce incidence of overgrown seedlings. An example schedule of batches of seedling production is presented in Fig. 4.

Nursery operations require training of supervisory personnel and labourers in order to produce healthy seedlings. Training topics for both labourers and nursery staff covers: selection of mother trees; seed collection, extraction and storage; pre-sowing treatments; sowing and application of mycorrhizal inoculants and beneficial microorganism-based biofertilizers; care and maintenance of seedlings including re-spacing and hardening-off; and selection of high quality seedlings before seedling dispatch to planting sites.

Seed procurement for locally available selected seeds starts in the year before the planting year. Timing for collecting locally available seeds is based on a tree seed calendar. An example of tree seed calendar is presented in Fig. 5. Genetically superior seeds were imported from certified suppliers at the University of Hawaii[5] for particular species including *Leucaena collinsii* and *L. leucocephala* var. K636. The seeds were propagated and planted at the GENESYS Seed Production Area. The average seed cost has been estimated at PhP 0.25/seedling produced, including all direct and indirect costs incurred in seed procurement.

The nursery personnel are responsible for preparation and implementation of the operational plan for seedling production, with support and coordination by the planning and logistics departments. The nursery operational plan and its

[5] No seed importation is currently taking place. Imports will only be obtained when existing SPAs cannot supply all the required quantity of seeds.

SRC TREE SEED CALENDAR														
	SPECIES	Seed Maturity Period												Location of Mother Trees/Suppliers
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	*Acacia auriculiformis*	■	■											Guimaras Island, Philippines
2	*Azadirachta indica*								■	■				San Carlos City, Negros Occidental, Philippines
3	*Calliandra calothyrsus*								■	■				Campuestohan, Talisay, Negros Occidental, Philippines
4	*Gliricidia sepium*												■	San Carlos City and Murcia, Neg. Occidental, Philippines
5	*Gmelina arborea*					■								San Carlos City, Negros Occidental, Philippines
6	*L. leucocephala K636*								■	■				GENESYS Seed Production Area, San Carlos City, Philippines
7	*Leucaena collinsii*								■	■				GENESYS Seed Production Area, San Carlos City, Philippines
8	*Melia dubia*											■		Sipaway Island, Negros Occidental, Philippines
9	*Parkia roxburghii*				■	■								University of Philippines at Los Banos, Laguna, Philippines
10	*Senna spectabilis*												■	San Carlos City, Negros Occidental, Philippines

Fig. 5 Tree seed calendar for selected SRC species

interrelations with various sections within the nursery department and other departments of the ECP project are described in Fig. 6.

Planting stock are raised from seeds under the following seedling production regime:

- The mixture of soil media for filling up the polybags consists of 6 parts (by volume) of sandy loam, 3 parts of compost-based organic fertilizer and 1 part of ricehull. Only fully decomposed materials are used. When the sandy loam is too compact, the aggregates have to be broken to loosen and crumble the loam to increase aeration. Screen or fine wire mesh are used to sieve the loam when necessary.
- Filled polybags are watered twice a day for at least 3 days before germinants are transplanted to reduce the temperature of the potting media.
- Large seeds that have high germination rates are sown directly into polybags. Small seeds and seeds that have low germination rate are sown in germination beds inside the germination house following pre-sowing treatments recommended for specific species. Small seeds are sown in lines with spacing of 5 × 1 cm and slightly covered with soil media to a maximum depth of 5 mm.
- One hundred grams of humic acid with 16 l of water are thoroughly dissolved and sprayed onto 1,000 newly transplanted germinants. The humic acid serves as a soil conditioner. Best results in terms of germinant survival rate are achieved when humic acid is applied to polybags immediately after transplanting or within 3 days.
- Mycorrhizal inoculation is performed during potting. A total of 5 g of Mycovam (endomycorrhizal associations) or of Mycogroe (ectomycorrhizal associations) powder, depending on tree species, is put into a hole at the centre of the polybags surface the depth of up to 5 cm immediately before germinant transplanting or direct seeding. Pisolithus isolate is applied to *Eucalyptus urophylla*, Mycogroe is applied at a dosage of 1 tablet/seedling to *Eucalyptus camaldulensis* and other *Eucalyptus* spp., while Mycovam is applied at a dosage of 5 g/seedling for leguminous species and other species.
- Fish hydrolysate and concentrated beneficial microorganisms (BM) are used as biofertilizer. One litre of hydrolysate is mixed with 1 l of BM in liquid form and diluted into 200 l of water. A 16-l solution (1 backpack sprayer) is used to spray 1,000 seedlings. Age of seedlings should be at least 1 week after transplanting

Major activities	Timing		Process of seedling production	Responsible organization	Details of activities
	Year (x-1)	Year x			
Construction of nursery structure with the required capacity (first year only).	Nov	Until Feb	NURSERY STRUCTURE ↓	ECP Manager and Nursery	Nursery structure is ready for operation by second week of February. Nursery structure will consist of: a. Greenhouse and shadehouse b. Tubes, trays and tray covers c. Irrigation system d. Sub-office and working shed e. Hardening-off /holding areas e. Tools
Issuance of Order to produce seedlings	Jan-Oct		SEEDLING ORDER ↓	Planning Dept.	Order details total area to be planted, location, species and composition and planned planting time. This will trigger seed collection.
		Until Feb.	CONFIRMATION OF ACCEPTANCE OF ORDER ↓	Nursery	Nursery will verify existing seeds, seed maturity period, other sources, quantity and quality of seeds
Seed procurement	Jan-Dec	Until Mar.	SEED COLLECTION AND PURCHASE ↓	Nursery	Based on confirmed seedling order and seed utilization value (%)
Pre-sowing preparation	Jan-Dec	Until Mar.	PREPARATION OF OTHER MATERIALS ↓	Greenhouse Section/Nursery and Logistic Dept.	Purchase and transportation of 1. Media, 2. Fertilizers 3. Mycorrhizal inoculants 4. Insecticide etc
Seed sowing, transplanting and maintenance and care of seedlings		Feb-May	SEED (DIRECT) SOWING ↓	Greenhouse Section/Nursery	Different sowing time will be determined by growth rate of seedlings of particular species and planned planting time
			TRANSPLANTATION OF GERMINANTS ↓	Greenhouse Section/Nursery	If germination rate is lower than expected, additional seeds will be sown
Re-spacing and hardening		Apr-July	RE-SPACING AND HARDENING-OFF SEEDLING ↓	Shadehouse and Hardening Section/Nursery	As soon as the canopies close, seedlings will be re-spaced and/or hardened in hardening-off/holding areas to prevent spindly seedlings
Seedling selection		May-July	SELECTION OF HEALTHY AND STURDY SEEDLINGS ↓	Shadehouse and Hardening Section/Nursery	Only sturdy and pest-/disease-free seedlings will be used. Sturdiness Index (SI) is 6 and below
		May-July	REQUEST FOR SEEDLING WITHDRAWAL ↓	Planning Dept.	Request will specify recipient farmers, species and quantity, location, proposed time and date of delivery
Seedling hauling to planting sites		mid-May-July	DISPACTH OF SEEDLINGS TO PLANTING SITES	Logistic Dept.	Seedlings transported to planting sites should be planted on the same day

Fig. 6 Operational plan for annual seedling production

for the first fertilizer application. Application with the same dosage is repeated every week for 3 weeks. Application of commercial mycorrhizal inoculants becomes optional since this type of biofertilizer already contains mycorrhizal fungi.

- The shade screen in the shade house is removed gradually to expose seedlings to increased sunlight intensity and eventually to full sunlight to prepare them for field outplanting. Seedlings are re-spaced when the leaves meet, to expose them to gradually increased sunlight intensity and then eventually to full sunlight.
- When seedlings are sufficiently hardened-off, seedlings are selected based on a set of quality standards, including sturdiness index and freedom of pests and diseases.[6]
- Mortalities and downgrade seedlings are replaced in the succeeding batch.
- Selected planting stock are transported to planting sites in a covered but well ventilated vehicle. Care is taken to avoid damage during transportation and handling. Upon arrival in the planting site, seedlings are kept in shaded areas.
- It is desirable that seedlings transported to the planting sites be planted on the same day. Thus, prior to seedling dispatch, availability of manpower for planting has to be assessed and indicated in the request for seedling withdrawal.[7]

Results and Discussion

The unit seedling cost is PhP 4.12/seedling inclusive of a hauling cost of PhP 0.55/seedling from nursery to accessible roadside nearest to planting sites. The breakdown of unit seedling cost is reported in Table 1.

The price of seedlings quoted by private seedling growers is in the range of PhP 5–15/seedling, considerably above the seedling cost from the centralized nursery, although some seedling growers charge only PhP 5/seedling. However, private seedling growers seek to produce as many as seedlings as possible to maximize profit, and there is a high risk of producing low quality seedlings by reduction of variable inputs and skipping quality enhancement procedures to reduce production cost. The most common quality enhancement procedures skipped by private seedlings growers are re-spacing and hardening-off, because these are considered to entail additional cost in producing the same quantity of seedlings.

Compared to individual decentralized and independently operated small dispersed nurseries, operation and maintenance of centralized nurseries is more efficient and has the following advantages:

[6] The sturdiness Index (SI) is the height of seedling (in cm) divided by root collar diameter (in mm). Seedlings with SI 6 and below are accepted, while seedlings with SI more than 6 are considered low quality, and are discarded. Combined mortalities and downgrade are a maximum 10% per species. The average overall mortality and downgrade is about 4%.

[7] Farmers are advised to provide sufficient manpower to plant one delivery load of seedlings. If there are seedlings unplanted on the day that they are delivered, farmers are advised to irrigate in the absence of rain and plant them the next day.

Table 1 Breakdown of unit seedling cost (P4.12/seedling)

Cost component	Cost amount (PhP)	Contribution to total cost (%)
Seed	0.25	6.07
Soil media	0.86	20.87
Other materials	0.76	18.45
Utilities	0.05	1.21
Labour	1.65	40.05
Seedling hauling	0.55	13.35

1. Purchase of inputs including seeds can be in bulk and with minimized freight cost and handling.
2. In the absence of a grant, the investment cost on the nursery structure and supporting facilities can be shared among planters, thus minimizing capital cost for individual planters.
3. The seedling production and planting schedule can be closely coordinated and synchronized, to avoid delays in planting which will result in overgrown seedlings.
4. The quality of seedlings can be better maintained and controlled because the operations and management of nursery activities is centralized.

In order for the nursery manager together with other nursery personnel to operate centralized nurseries cost-effectively, knowledge and strict compliance of the following factors is critical:

1. The objective of seedling production is clearly defined by ‘targeting’ seedling production to anticipated harsh conditions at the out-planting site.
2. Nursery personnel are familiar with species characteristics at seedling stage.
3. The prescribed seedling production regime is closely followed.
4. Seedlings are provided to planting sites at most 50 km from the nursery.[8]

In summary, financial advantages and greater quality control are apparent for centralized seedling production relative to scattered small-scale nurseries. This justifies the need of a centralized nursery, at a time when general thinking is that a ‘decentralized seedling production scheme’ is the key to the promotion of small-scale forestry.

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[8] It seems to be a practice in Negros Island that a relatively low transport rate applies for a maximum distance of 50 km. For greater distances, the number of trips a truck can make per day is reduced and the freight charge increases substantially.

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